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Generator bearing defect development based on discrete fault stages

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Introduction

CMS is employed by OEM and O&O as part of the condition based maintenance strategy, both in onshore and offshore wind farms. The main objectives are:

1. Reduce cost of energy (CoE)
2. Increase energy and time availability
3. Optimize maintenance and component replacement

Commonly, vibration-based CMS is applied on monitoring of the main drive-train components and tower oscillations.

Generator bearing monitoring

Monitoring of generator bearings is performed by radially installed accelerometers close to the load zone. A wide variey of faults is detectable, such as

- ✓ subcomponents defects (ball, cage, inner & outer race)
- ✓ rotor dynamic faults (imbalance, misalignment, looseness)
- ✓ slip ring unit malfunction in DFIGs

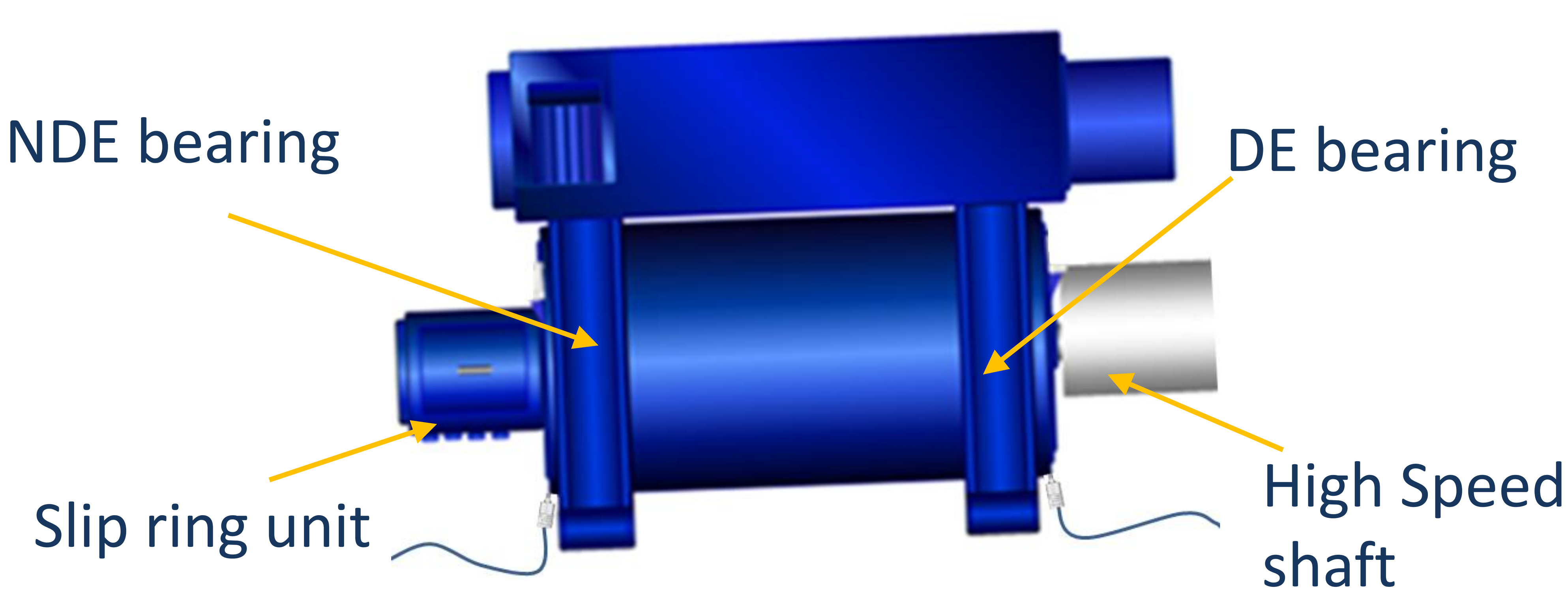

Fig. 1: Positioning of accelerometers and main parts of a DFIG

Severity estimation

B&K Vibro CMS combines an automated alarm generation system with operator interaction in alerting, diagnosing and evaluating the severity of a developing fault. Four discrete severity levels are employed, providing suggestions on the criticality of a fault and lead time to inspection and planning of any required maintenance needs.

Severity	Type	Description	Recommended Action
1	Danger	Severe progressing alarm	Immediate action. Operating the turbine has serious risk of functional loss and possible severe consequential damage.
2	Alert	Considerable progressing alarm	Action as soon as possible. Recommended within 2-4 weeks.
3	Alert	Progressing alarm	Action when convenient. Recommended within 2-4 months.
4	Alert	Small or none progressing alarm	No Action Required / No Feedback Required

Development of bearing faults

Data set consists of:

- 119 bearing defects (mainly BPFI), which have lead to
- 340 alarm reports of various severity.

The main observations are:

- Sev4 ⟶ Sev3: 80% of faults are upgraded within 10 months - 60% within 4 months
- Sev3 ⟶ Sev2: 80% of faults are upgraded within 4 months - 60% within 2 months
- Sev2 ⟶ Sev1: 85% of faults are upgraded within 2 months

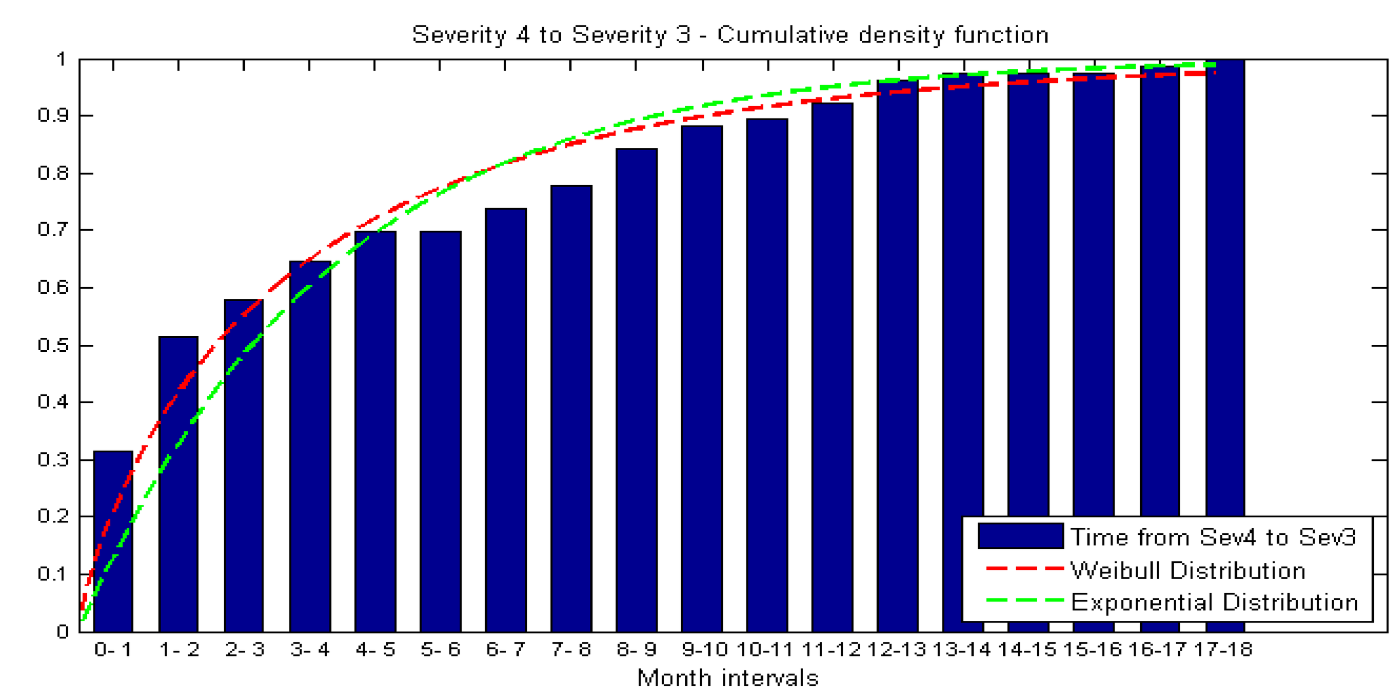

Fig. 2: CDF of time interval for a fault to be upgraded from Severity 4 (lowest) to Severity 3

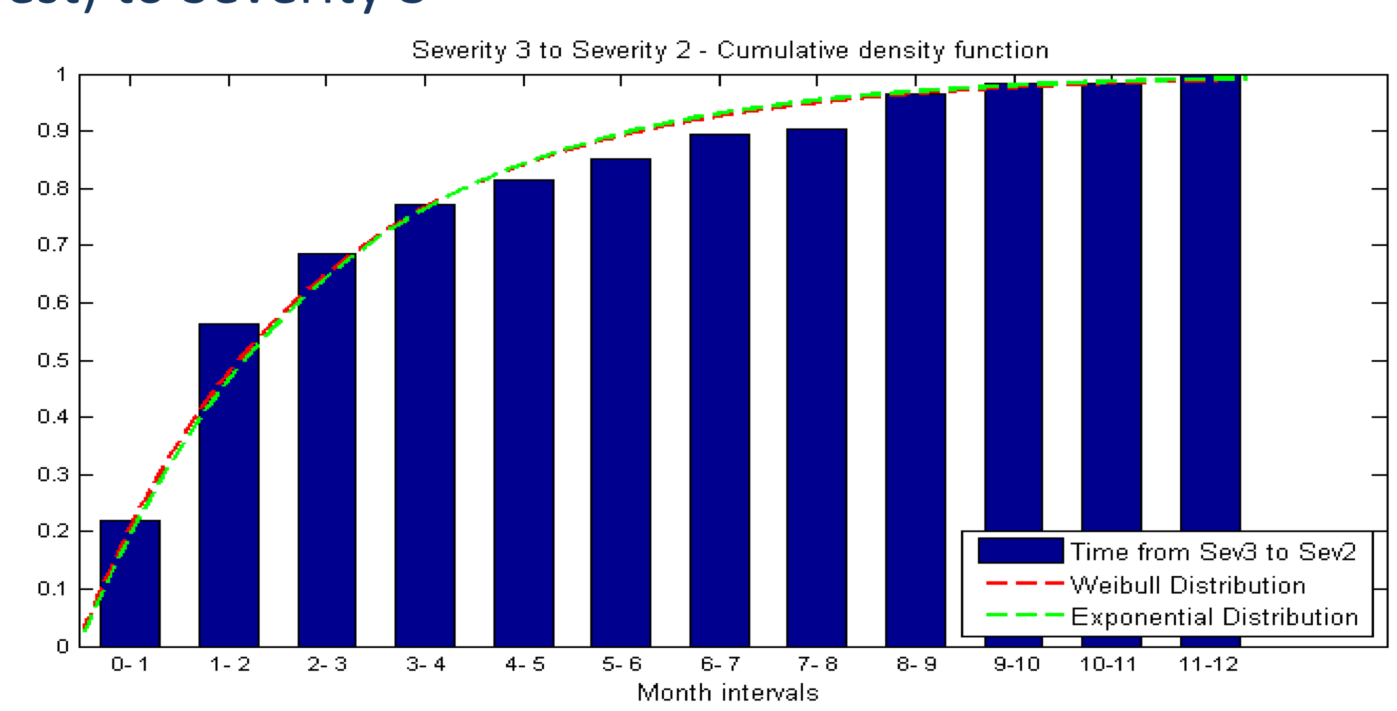

Fig. 3: CDF of time interval for a fault to be upgraded from Severity 3 to Severity 2

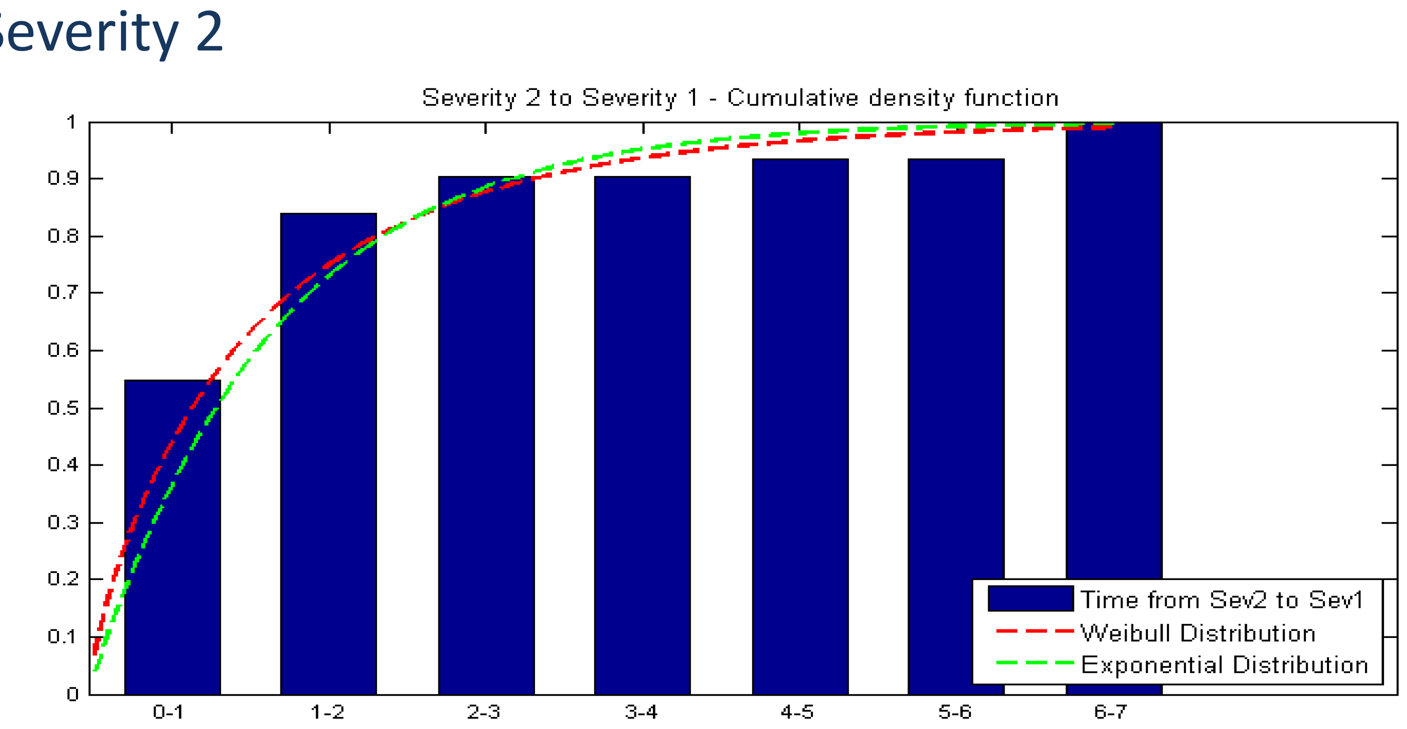

Fig. 4: CDF of time interval for a fault to be upgraded from Severity 2 to Severity 1 (highest)

Conclusions

- Fault progression is faster as higher severity levels are reached
- Upgrade time is consistent with provided lead time